STATEMENT OF BASIS/FINAL DECISION AND RESPONSE TO COMMENTS SUMMARY

REGION II
ID# 9999

Army Garrison – Fort Buchanan
Northwest Boundary Area
Bayamón, Puerto Rico
(signed October 16, 2012)

Facility/Unit type:	**Northwest Boundary Area**
Contaminants:	**Trichloroethylene (TCE), Tetrachloroethylene (PCE), cis- and trans-1,2-Dichloroethylene (DCE), Vinyl Chloride**
Media:	**Groundwater**
Remedy:	**Enhanced Bioremediation-Reductive Dechlorination, Long-term Monitoring and Land-Use Controls.**

FACILITY DESCRIPTION

The Army Garrison-Fort Buchanan (Fort Buchanan), with oversight from the United States Environmental Protection Agency (EPA), engaged in a voluntary corrective action after volatile organic compounds (VOCs), primarily trichloroethylene (TCE), were detected at concentrations up to 154 micrograms per liter (µg/L) in groundwater monitoring well samples collected within the adjacent property (now Puma Energy Caribe LLC) in 2004.

Fort Buchanan (the facility) is located approximately 10 kilometers southwest of San Juan, Puerto Rico. The installation is bordered by Roosevelt Avenue to the east, road PR-No. 2 to the south, road PR-No. 28 to the immediate northwest (with Puma Energy Caribe LLC beyond) and De Diego Expressway to the north. The installation occupies approximately 746 acres within two municipalities, Bayamón and Guaynabo. Physiographically, the facility is located on the northern coastal plain of Puerto Rico, which is about 5 miles wide and slopes gently upward to the central mountain chain, the Cordillera Central.

The facility was established in 1923 under the name of Camp Buchanan, originally located on a 300-acre tract of land approximately six miles south of San Juan Bay. From 1926 to 1930 Camp Buchanan was used as a maneuver training area and range by the regular Army, by National Guard troops, and as a Citizen Military Training Camp. In 1940 it was designated as Fort Buchanan and expanded to 1,514 acres, later expanding to 4,500 acres. After World War II, the Installation was gradually reduced in size to its present 746 acres. Today, Fort Buchanan continues to support the reserve- and active-component soldiers in Puerto Rico and the U.S. Virgin Islands. Its principal mission is the mobilization, readiness and actual deployment of approximately 15,000 reserve-component soldiers in Puerto Rico and the U.S. Virgin Islands. The installation also provides support to Department of Defense operations in the Caribbean area.

SITE GEOLOGY AND HYDROGEOLOGY

According to the geologic maps of the Bayamón Quadrangle and the San Juan Quadrangle, the coastal plain, wherein the facility lies, consists of unconsolidated deposits of Quaternary Age alluvium sands, silts, and clays which characterize the northern two-thirds of the surface geology of the facility and most of the relatively flat central valley installation areas. A range of Neogene age limestone (Aguada) outcrops, known as Montes de Caneja, occurs along the northern boundary of the facility, and a second ridge, which is part of the Cibao formation, forms the southern boundary. The Cibao Formation stratigraphically underlies the Aguada Formation.

Data obtained during the current Northwest Boundary (henceforth the Contaminated Area Site or CAS) Resources Conservation and Recovery Act Facility Investigation (RFI) indicates that, while not uniform across the CAS, approximately 20 to 40 feet (ft) of clay overburden was encountered prior to contact with the uppermost carbonate sand aquifer. The overburden tended to thicken as the investigation moved northward. Underlying the clays and silts were varying degrees and ranges of a carbonate sand unit comprised of fine to large gravel and coarse sands, mostly yellow to pale brown in color. Beneath the water table, these zones were mostly saturated. In many of the wells, two distinct carbonate zones (older and younger terrace zones) were found separated by approximately two to 20 ft of fine material. However, data gathered during the installation of the seven northernmost wells suggested one carbonate sand layer north of the site. Underlying the carbonate layer was often a greenish gray silt material.

The hydrogeology of the CAS consists essentially of a two-aquifer system that is connected, with the older terrace being the source for the recharge of the younger terrace. The older terrace occupies the southern end of the study area in the uplands, while the younger terrace represents the northern lowlands. Both aquifers are in the carbonate sands. Low-permeability overburden covers the area; thereby preventing, or limiting, infiltration in the study area. The upland area to the south provides recharge to the study area. The overburden thins out in the southern uplands, and the aquifer surfaces there to recharge. The older terrace material consists of alternating sand and silt, and dips below the younger terrace material. It has a strong, immediate response to rain events, and is not affected by tides. The younger terrace, alternatively, forms the northern half of the study area. It communicates with the older terrace, but not excessively. It is also an alternating sand/silt one-to-two aquifer system. The wells within the younger terrace have a lesser response to rainfall, and are affected by tides. Groundwater flows south to north, with a steep gradient from the southern end of the investigation area and flattening out north of the Directorate of Public Works (DPW) complex and across Route 28. Groundwater levels are tidally influenced in many of the wells.

EXPOSURE PATHWAYS

Concentrations of Volatile Organic Compounds (VOCs) in groundwater exceeding the Maximum Contaminant Levels were detected in Phases I through IV of the RFI. Phases V through VII included geophysical, soil, and surface water investigations. The majority of the VOCs that were detected are chlorinated solvents in groundwater and their different breakdown phases. The breakdown products of PCE and TCE are cis- and trans-1,2-dichloroethylene (DCE), vinyl chloride, and finally ethene. Groundwater within the CAS contains PCE and TCE, and to a lesser extent 1,2-DCE and vinyl chloride. The horizontal extent of elevated concentrations of PCE, 1,2-DCE, and vinyl chloride is generally limited to the facility; notable concentrations of these analytes have not been detected north of the installation. The horizontal extent of TCE is more widespread and extends north from the facility boundary.

The compound most frequently detected in groundwater during the sampling events was TCE. Results of the Northwest Boundary RFI indicate that the area of highest TCE concentrations in groundwater is within an open field area east of the DPW complex (4,040 µg/L). VOCs were detected in off-post monitoring wells north of the installation, with TCE detected at concentrations up to 141 µg/L. Soil samples were collected from soil borings and test pits during the Northwest Boundary RFI. No VOCs were detected above screening levels in any of the soil samples.

The RFI risk screening evaluated groundwater and soil as potential media of concern for human receptors at the facility. Exposure to VOCs released from groundwater into indoor air was identified as a complete potential exposure pathway. There are currently no buildings within the plume area on the CAS which are regularly occupied, and the facility's Master Plan does not include any residential development within the CAS. However, there are no restrictions against building other structures at the CAS. Although the area is served by a public water supply (Puerto Rico Aqueduct and Sewer Authority), there is no formal restriction on the use of groundwater at the facility. Therefore, the potential human receptors evaluated in the RFI included an adolescent trespasser, commercial worker, construction worker, and off-site resident adult and child.

The risk assessment determined there are no potential concerns for human contact to soil and surface water within the CAS. There are potential concerns for the commercial worker and off-site resident exposure to groundwater. For the commercial worker, there are potential concerns for inhalation of indoor air from vapor intrusion. As noted above, there are currently no buildings within the CAS that are occupied on a regular basis. However, any buildings constructed within the CAS should take into account potential vapor intrusion of VOCs from groundwater to the indoor spaces. There are potential risk concerns for off-site resident exposure to groundwater as a drinking water source. At the moment, no drinking water wells exist off-site. The primary contributor to groundwater concerns is TCE. No ecological risks have been identified at the CAS.

SELECTED REMEDY

Remedy selected consists of a combination of Enhanced Bioremediation – Reductive Dechlorination, Long-term Monitoring, and the establishment of Land-Use Controls (LUCs). The estimated cost of this alternative is $1,973,000. This alternative involves enhanced bioremediation via anaerobic dechlorination using substrate, electron donor, and nutrient injection (as required) to address areas of the greatest groundwater impacts, a long-term monitoring program to assess trends in natural attenuation and contaminants of concern (COCs) in groundwater over time, and LUCs prohibiting the use of groundwater as a source of drinking water until the COCs in groundwater are below the remedial goal and requiring vapor mitigation for any new structures, as necessary, to prevent exposure to the COC above indoor air levels due to vapor intrusion.

The bulk of the remediation of the COCs at the CAS would occur during the enhanced bioremediation phase of the remedy. Enhanced bioremediation was selected to accelerate degradation of the COCs in the area of the highest concentrations. The interim remedial goal for this phase of the remedy is 100 µg/L for TCE, which is expected to result in achievement of the final remedial goal of 5 µg/L for TCE within a reasonable timeframe of

30 years. Long-term monitoring would be conducted to ensure that COCs continue to attenuate and that the remedial goals are achieved. Periodic reviews would be conducted, because the COCs would be present in groundwater at concentrations that exceed the remedial goal after implementation of the enhanced bioremediation portion of the remedy and before attenuation of the COCs to the remedial goal is complete.

INNOVATIVE TECHNOLOGIES CONSIDERED

Applicable remedial technologies were evaluated in a Corrective Measures Study. Some of these technologies are considered innovative, and may provide advantages over traditional technologies. The innovative technologies considered for this CAS included *in situ* chemical oxidation, *in situ* chemical reduction, and enhanced *in situ* bioremediation. These *in situ* technologies are preferable to traditional technologies which would require groundwater extraction and *ex situ* treatment, because they are more effective in terms of overall treatment, remediation timeframe, and cost. An innovative technology, enhanced *in situ* bioremediation, was chosen as part of the selected remedy for this CAS. Bioremediation of TCE, PCE, and their breakdown products DCE and vinyl chloride occurs when microorganisms in the environment degrade these compounds in a process called reductive dechlorination. Bioremediation can be enhanced, or accelerated, by providing additional nutrients and/or microorganisms to the subsurface to increase the population and activity of the microorganisms capable of degrading these contaminants. Enhanced *in situ* bioremediation is an extremely effective technology for treating chlorinated compounds such as TCE, and has been utilized effectively at other sites containing TCE and related compounds in groundwater. Furthermore, previous groundwater investigations within the CAS have indicated that the site conditions are suitable for the use of this technology.

PUBLIC PARTICIPATION

On June 19, 2012 a notice inviting the public to comment on the proposed remedy for the CAS was published by EPA on the *Primera Hora* newspaper. A 45-day public comment period on the proposed remedy was opened from June 19 to August 2, 2012. No public meeting was necessary since it was not requested by the public and no comments on the proposed remedy were made.

NEXT STEPS

Following approval of the Corrective Measures Study EPA will evaluate the Corrective Measures Implementation Work Plan and Remedy Construction.

CONTAMINATION DETECTED AND CLEANUP GOALS

Media	Estimated Volume	Contaminants	Maximum Concentration	Action Level	Cleanup Goal	Point of Compliance
Groundwater	6,340,320 ft^3	TCE PCE 1,2-DCE Vinyl Chloride[1]	4,040 µg/L (TCE)	• 5 µg/L (TCE, PCE) • 70 µg/L (1,2-DCE) • 2 µg/L (Vinyl Chloride)[1]	• 5 µg/L (TCE, PCE) • 70 µg/L (1,2-DCE) • 2 µg/L (Vinyl Chloride)[1]	area of the TCE plume within the existing monitoring well network that exceeds 100 µg/L

KEY WORDS:

Groundwater, soil, Volatie Organic Compounds, chlorinated solvents, TCE, PCE, bioremediation, reductive dechlorination, chemical oxidation, Natural Attenuation

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[1] Although a more stringent Water Quality Standard for Vinyl Chloride (0.25 µg/L) in groundwater has been established by EQB based on Human Health, the contaminated groundwater at the CAS does not discharge into nearby water bodies (e.g. streams, sea, wetlands, etc.). The only potential risk concern would be for off-site resident exposure to groundwater as a drinking water source. At the moment, no drinking water wells exist off-site. Therefore, the National MCL for Vinyl Chloride can be used as the cleanup goal for this site.